

Historic, archived document

Do not assume content reflects current scientific knowledge, policies, or practices.

Issued August 24, 1907.

U. S. DEPARTMENT OF AGRICULTURE.

FARMERS' BULLETIN 302.

SEA ISLAND COTTON:

ITS CULTURE, IMPROVEMENT,
AND DISEASES.

BY

W. A. ORTON,

PATHOLOGIST, BUREAU OF PLANT INDUSTRY.



WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1907.

LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF PLANT INDUSTRY,
OFFICE OF THE CHIEF,
Washington, D. C., May 15, 1907.

SIR: I have the honor to submit herewith a paper entitled "Sea Island Cotton: Its Culture, Improvement, and Diseases," which has been prepared by Mr. W. A. Orton after study of the subject for the past seven years.

The paper presents the essential points of a system of culture that should be adopted by growers of Sea Island cotton in Georgia and Florida to overcome the constant deterioration due to lack of seed selection and want of proper care in the handling of this delicate product.

It is desired to acknowledge the assistance received from many planters on James and Edisto Islands, South Carolina; also the active cooperation of the A. P. Brantley Co., of Blackshear, Ga., and of others who have taken part in the experiments carried on in Georgia during the past three years.

I recommend the publication of this manuscript as a Farmers' Bulletin.

Respectfully,

B. T. GALLOWAY,
Chief of Bureau.

HON. JAMES WILSON,
Secretary of Agriculture.

CONTENTS.

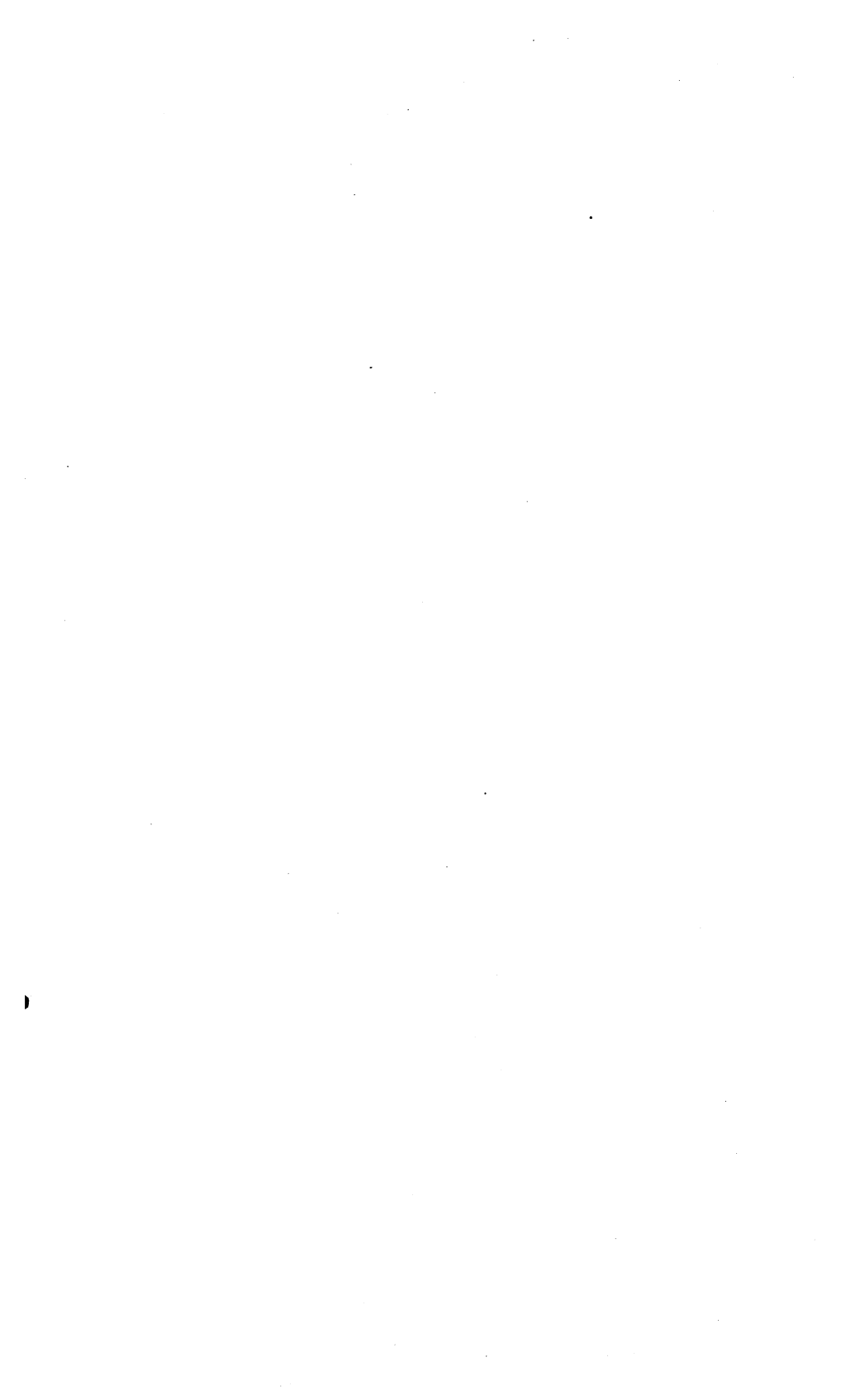
	Page.
Introduction.....	7
Geographical distribution of Sea Island cotton in the United States.....	7
Ideal crop requirements.....	9
Soil.....	9
Moisture.....	9
Humus.....	9
Location and exposure.....	9
Labor.....	10
Possible extension of the Sea Island cotton-producing area.....	10
Markets.....	11
Factors governing prices.....	12
Farm practices.....	14
Seed selection the first requirement.....	14
Preparation of the staple for market.....	15
Better culture means larger crops.....	16
Credit and the rental system a bar to progress.....	16
Defects in market conditions.....	16
Cultivation of Sea Island cotton.....	16
Rotation and diversification.....	16
Rotation systems.....	18
The choice of a legume.....	18
Resting land.....	19
Fertilizers for Sea Island cotton.....	20
Present practices.....	20
General principles governing the use of fertilizers.....	20
Effect of nitrogen.....	21
Effect of potassium.....	21
Effect of phosphorus.....	22
Lime usually unnecessary.....	22
The best formula.....	22
Quantity to the acre.....	22
Methods of application.....	23
Preparation of the land.....	23
Ridge culture.....	23
Level culture.....	25
Plowing should be deep.....	25
Vegetable matter should be ployed in.....	25
Fertilizing and bedding.....	25
Planting.....	25
Time of planting.....	25
Cultivation.....	26

	Page.
Seed selection.....	26
Origin of Sea Island cotton.....	26
Continued breeding necessary.....	26
Sea Island methods.....	27
Sea Island varieties.....	27
Breeders' rights.....	27
Sale of seed from the Sea Islands.....	28
Seed selection will succeed in the interior.....	28
Methods of selection.....	28
Roguing.....	28
General selection.....	29
Pedigree breeding.....	30
Beginning the selection.....	30
Second year: The progeny test.....	31
Third year: The increase plot.....	32
Fourth year: The general crop.....	32
Separate ginning of the seed crop important.....	32
Improvement of cotton seed by gravity separation.....	33
Ideal qualities of Sea Island cotton.....	33
Length of staple.....	33
Uniformity of staple.....	34
Strength of staple.....	34
Percentage of lint to seed.....	34
Color of staple.....	34
Fineness.....	35
Productiveness.....	35
Form and size of plant.....	35
Bolls.....	36
Seed.....	36
Earliness.....	36
Disease resistance.....	36
Handling the crop.....	36
Preserving the full value of the crop.....	36
Grade: Definition, and importance.....	37
Defects influencing grade.....	37
Loss of bloom or luster.....	37
Loss of strength.....	37
Nep.....	37
Broken leaf, etc.....	38
Short fibers.....	38
Weak fibers.....	38
Lack of uniformity in the bale.....	38
Yellow cotton.....	39
Sand.....	39
Moisture.....	39
Injury in ginning.....	40
Summary.....	40
Diseases of Sea Island cotton.....	41
Sore-shin and damping-off.....	41
Bacterial blight.....	41

Diseases of Sea Island cotton—Continued.	Page.
Wilt	43
Cause	44
Soil treatment not a successful remedy	45
The relation of soil conditions to wilt	45
Control through the use of resistant varieties	45
Control through originating new varieties	46
Root-knot	46
Anthrachnose	47
Remedies	47
Rust	47
Blue cotton	48
Insect enemies of Sea Island cotton	48

ILLUSTRATIONS.

	Page.
FIG. 1. Map of the Sea Island cotton area of the United States, showing distribution by counties	8
2. Bag of Carolina-grown Sea Island cotton, showing the style of package used on the Sea Islands	12
3. Bale of interior-grown Sea Island cotton, showing the style of package used in Georgia and Florida	12
4. Cross section of the beds on which cotton is grown on the Sea Islands	23
5. Double roller used on the Sea Islands to prepare the beds for planting cotton	24
6. Good and "run-out" seed cotton	29
7. Diagram of a pedigree breeding plat	32
8. Ideal form of cotton plant	35
9. Locks of Sea Island cotton from healthy bolls compared with hard locks from diseased bolls	38
10. Diseased leaves, boll, and stems of cotton plant showing several forms of bacterial blight	42
11. A plant recently affected with cotton wilt, with a healthy resistant plant growing beside it	43
12. Roots of a cotton plant affected with root-knot	44
13. Cotton boll affected with anthrachnose	47



SEA ISLAND COTTON: ITS CULTURE, IMPROVEMENT, AND DISEASES.

INTRODUCTION.

Our country can feel a just pride in the Sea Island cotton industry, for it produces the longest, finest, and most valuable cotton grown in the world. Its silky staple is used for spinning fine fabrics and laces and is of paramount importance to the thread industry, which requires a considerable part of the crop. Where great strength and durability are essential, as, for instance, in United States mail bags and in pneumatic tires, Sea Island cotton is also employed. The highly organized and laborious methods of culture, the excellent system of seed selection, and the painstaking care of the product which have maintained the high quality of the cotton grown on the Sea Islands are matters of special interest.

It is quality rather than quantity that gives economic importance to the Sea Island cotton industry, for the total annual production is less than 1 per cent of the American crop, or an average for the past seven years of 94,000 bales per annum.

An improvement in quality, an increase in production, and a greater profit to the acre are all possibilities of the future. They will result from the general adoption of improved methods and the extension over the whole Sea Island cotton belt of the careful system of seed selection and handling now practiced in one portion of the area. On the other hand, conditions are such that the industry may in time be crushed by competition unless the farmers awake to the necessity of considering the needs of the consumer as regards quality and purity and learn that the cost of production per pound can be reduced by increasing the yield per acre and that a diversified cropping system is safer and more profitable than the all-cotton plan.

GEOGRAPHICAL DISTRIBUTION OF SEA ISLAND COTTON IN THE UNITED STATES.

The successful cultivation of Sea Island cotton in this country is confined to the area lying southeast of a line drawn from Georgetown, S. C., to a point in western Florida. The accompanying map, figure 1, shows the approximate quantity produced in each county in this district, each dot standing for 500 bales or a fraction thereof.

In South Carolina the center of production is on the Sea Islands along the coast, where the finest staples are grown. The chief of these islands are James, Edisto, John, and Wadmalaw.

It is interesting to learn that in Georgia the coast counties produce scarcely any cotton, owing to the unfavorable character of the country, the absence of the necessary labor, and the predominance of the lumbering and trucking industries. The interior counties which grow Sea Island cotton extensively also produce considerable Upland cotton.

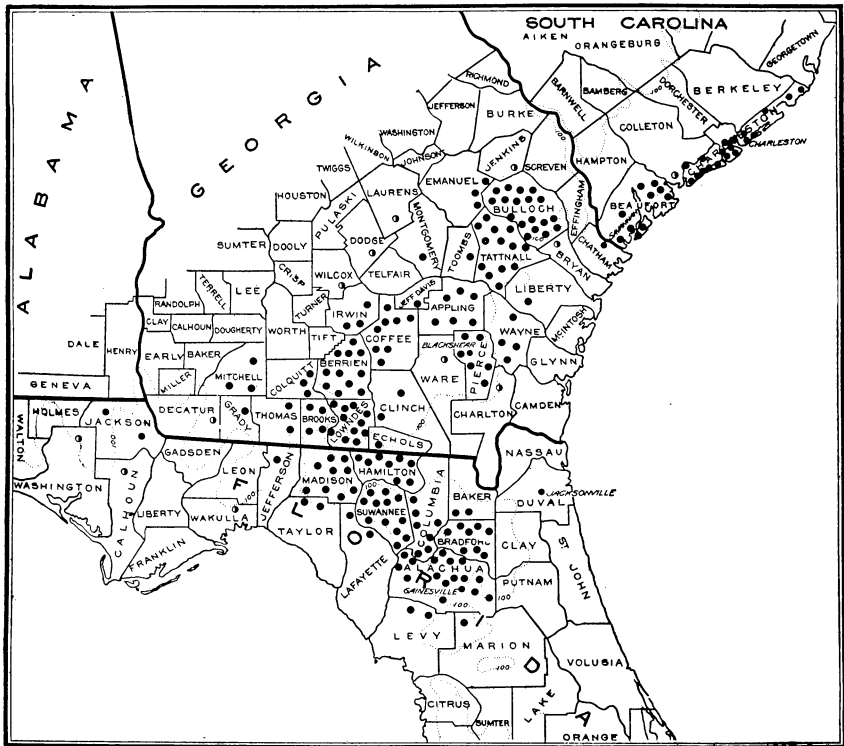


FIG. 1.—Map of the Sea Island cotton area of the United States, showing distribution by counties. Each dot stands for an average production of 500 bales.

In Florida a similar condition exists. Cotton is not grown on the coast, but is confined to the interior counties in the north-central portion of the State. Here the proportion of Upland to Sea Island cotton is much smaller, until one reaches the western counties, where conditions are less favorable for the long-staple cotton and where the Upland type is mainly grown.

The annual crop fluctuates widely, according to the nature of the season, but the average yield in bales of not quite 400 pounds each during the past five years has been as follows: South Carolina, 10,957 bales; Georgia, 50,311 bales, and Florida, 33,749 bales.

IDEAL CROP REQUIREMENTS.

Several factors must be considered when seeking a location for growing Sea Island cotton. Those mentioned here affect not only the yield but the quality of the staple, its color, and the percentage of lint to seed. The relative influence of the various factors is, however, not always determinable.

SOIL.

The crop requires a sandy or a sandy loam soil, preferably with a clay or compact sand subsoil about a foot below the surface. Most of the Sea Island cotton is grown on the soil type classified by the Bureau of Soils as Norfolk fine sand, with lesser areas of Norfolk sand, Norfolk sandy loam, and related types. On the Sea Islands, where a clay subsoil is rarely found, the growers seek to maintain a compacted layer beneath the plants by the tramping of stock during the year the land is resting. The interior growers prefer a clay subsoil, but sometimes plant cotton on quite deep sand, where the quality is satisfactory; the yield is smaller, however, in such cases.

MOISTURE.

A well-regulated water supply is the most important factor influencing Sea Island cotton. Thorough drainage is essential. On this account more and better cotton is grown on the slightly elevated margins of the Sea Islands than in the lower central portions. Tile drains make possible the cultivation of land otherwise too wet. In the interior, cotton is grown only where there is suitable drainage. On the other hand a liberal and regular supply of water is needed, and wherever cotton is planted on the dry hills in the upper edge of the Sea Island cotton belt inferior results are secured, the staple becoming shorter and harsher. The lower lying lands are better, provided they have adequate drainage.

HUMUS.

Soils very rich in humus appear to be unsuited to Sea Island cotton, producing too rank a growth; but a deficiency of humus is also a serious objection, as such land produces a small plant with a tendency to the shedding of bolls and to rust.

LOCATION AND EXPOSURE.

Atmospheric humidity appears to be a prominent factor influencing the quality of the staple. On the Sea Islands, fields having an ocean exposure are said to produce a finer and glossier staple on account of the moisture-laden ocean breezes, and in the interior one advantage of the lower lands is doubtless their moist air, which is conserved by protecting forests and near-by swamps. In the absence of sufficient

moisture in the air the staple becomes harsh and shorter. This is further shown by the fact that a wet season is more favorable to Sea Island than to Upland cotton, while the Upland varieties do better in a dry season. The relative production of Upland and Sea Island cotton in the northern counties fluctuates with the season and the changes in acreage due to varying market conditions.

The mixing of seed and the hybridization which result from planting cotton of both types in the same community is a serious handicap to the growers of Sea Island cotton. In this respect portions of Florida where only Sea Island cotton is grown possess a marked advantage, and the introduction of Upland varieties should be discouraged.

LABOR.

In addition to the effect of high prices in stimulating the industry and of low prices in depressing it, a factor which must be considered in connection with the production of cotton in either old or new sections is the supply of available labor. Until present methods are revolutionized a relatively large amount of fairly cheap labor is required, and it is a great advantage if the laborers have had long experience with the crop. Throughout the Sea Island cotton belt there is now a growing scarcity of labor, which is likely to restrict the acreage planted. The farmers must meet the new conditions by the adoption of labor-saving machinery in planting and in cultivation, but there will continue to be difficulty in getting the cotton picked.

The development of trucking and lumbering industries restricts the less profitable cotton crop, and there is a steady exodus of laborers to engage in railroad building, etc., making the labor problem still more serious.

POSSIBLE EXTENSION OF THE SEA ISLAND COTTON-PRODUCING AREA.

It has been predicted that there will be in the future a constant increase in the world's consumption of Sea Island cotton, requiring a corresponding increase in production. Sections outside the present Sea Island cotton belt have from time to time attempted to engage in its culture, but such extensions of area are unnecessary and do not promise a profit. No other portion of our cotton belt is as well adapted to the crop as the area in which it is now grown. This is shown by the fact that during the past hundred years very many attempts have been made to grow Sea Island cotton in other States, and all have failed. Such extensions are unnecessary, because several times as much as the present crop could be produced in the area now devoted to Sea Island cotton, if circumstances required it. This increased production could be accomplished in part by clearing and

planting new land, for neither on the Sea Islands nor in the interior counties is more than a small fraction of the land under cultivation, and in part by increasing the yield per acre, which could be doubled by better cultural methods and the practice of seed selection. An additional increase would result from the substitution of Sea Island for Upland cotton in the border counties where both are now grown.

Serious obstacles are met with in introducing Sea Island cotton into a new section. There is difficulty in securing the proper care in cultivation and in picking and handling the staple. Pickers accustomed to Upland varieties object so much to the small and partly closed Sea Island bolls that it is difficult to get the cotton picked even at the prices now paid—\$1 to \$1.25 a hundred pounds. The ginning must be done on a roller gin, as the saw gin injures the staple too much, and a specially equipped ginnery is therefore necessary. Further difficulties are met with in marketing the product, which at first can rarely be sold to advantage in a local market where the buyers are unaccustomed to the Sea Island staple. Shipment to a recognized market for Sea Island cotton is necessary in such cases.

MARKETS.

The cotton grown in South Carolina is marketed at Charleston, while the interior crop is handled at Savannah, Blackshear, and Valdosta, Ga., Madison, Fla., and other interior towns. There is a marked difference in the style of bale in the two cases. South Carolina cotton is put up in bags, $7\frac{1}{2}$ feet long and about $2\frac{1}{2}$ feet in diameter, containing 300 to 400 pounds. (Fig. 2.) They are filled by hand and pressed in a light hand-screw press. Compression for export is not practiced. As the use of this bag has been confined to the Sea Islands, it serves as a trademark to distinguish the crop in foreign markets.

In the Charleston district the finest cotton is that grown by a limited number of planters who have for many years paid the most careful attention to seed selection. Their cotton is not only long and fine but is picked with so much regard to cleanliness and uniformity that the grower's private brand on the package is often a sufficient guarantee of its quality.

These fine "crop lots" comprise about 35 per cent of the cotton marketed in Charleston and sell for from 30 to 60 cents a pound. They are all exported. The demand for this extra-fine and high-priced cotton is very limited. The remainder of the South Carolina crop is sold in the usual manner at lower prices. The higher price secured for South Carolina cotton is largely because of its superior preparation, all stained and weak cotton and bits of leaf being removed before baling.

Interior Sea Island cotton is packed by a steam press into bales weighing about 400 pounds each, of the same shape and size as an

Upland cotton bale, 54 inches by 27 inches (fig. 3). They are covered with heavy burlap, secured by sewing with strong cord instead of by the steel ties used on bales of Upland cotton.

The buyers classify interior cotton first by length of staple into "East Floridas," $1\frac{3}{4}$ inches to 2 inches; "Floridas," $1\frac{5}{8}$ inches to $1\frac{3}{4}$ inches; and "Georgias," $1\frac{5}{8}$ inches but less fine than Floridas. These names have come to be applied without regard to the source of the cotton. The length of staple is mainly influenced by seed selection, but in part by the

FIG. 2.—Bag of Carolina-grown Sea Island cotton, showing the style of package used on the Sea Islands.

character of the soil. Each of these classes is subdivided into grades with reference to its preparation and appearance, the usual grades being fancy, extra choice, choice, extra fine, fine, and "dogs." The difference of 5 to 10 cents a pound between fancy and fine shows the possible gain to the farmer from careful preparation. Loss of grade is due to exposure to weather before picking, to storing or ginning when too wet, and especially to the presence of stained or yellow cotton and bits of leaf or other trash.

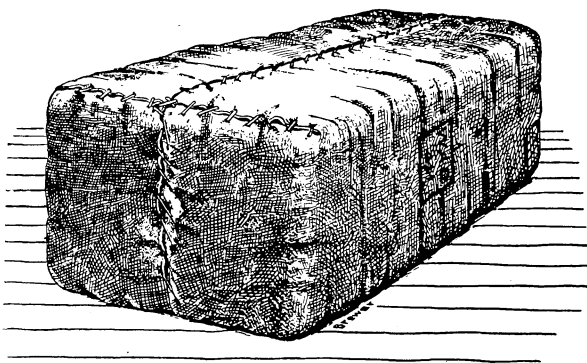


FIG. 3.—Bale of interior-grown Sea Island cotton, showing the style of package used in Georgia and Florida.

FACTORS GOVERNING PRICES.

There is a fairly uniform demand for a few hundred bags of extra-fine cotton with staple of 2 inches and over, and, for what the market

requires, a high price, 50 to 80 cents a pound, will be paid. A larger quantity of this long-staple cotton is difficult to sell at any price. For the medium grades ($1\frac{3}{8}$ inches to $1\frac{1}{2}$ inches) there is a liberal demand at prices determined by the law of supply and demand. The size of the crop in Georgia and Florida is the principal factor in establishing the price, but other long staples exercise considerable influence.

Sea Island cotton is only slightly affected by the fluctuations of short-staple Upland cotton, but the amount and quality of the long-staple Upland crop seriously affect the lower grades of Sea Island cotton. Staples less than $1\frac{3}{8}$ inches long sell well only in a year when the long-staple Upland crop is inferior. This long-staple Upland cotton is grown mainly in the Mississippi Valley, and as it can be produced at a less cost than Sea Island cotton it is evident that the latter must not be permitted to become less than $1\frac{3}{8}$ inches in length, in order to avoid this competition.

The next quality of staple competing with Sea Island cotton is the Egyptian. Of this an amount equivalent to about 1,500,000 Sea Island bales of 400 pounds is produced every year in the Nile Valley, and 147,000 such bales are annually imported into America. An average price is 15 cents a pound. Egyptian, while not as long and fine as Sea Island cotton, is very strong and free from waste, owing to careful preparation. It wastes in the mill 8 per cent less than Sea Island cotton, the average waste in the different processes of preparing for spinning being 33 per cent for the Sea Island and only 25 per cent for Egyptian. Much of the Egyptian cotton is decidedly shorter than Sea Island, but the Jannovitch variety and to some extent the Abassi are, in particular, competitors of Sea Island of $1\frac{3}{8}$ -inch staple or less and will continue to be used in preference to the American product, even in our own mills, until the interior Sea Island growers improve their product.

Mr. A. P. Brantley, a well-informed buyer and exporter of Sea Island cotton, writes as follows:

Jannovitch has, during the last few seasons, commanded practically as much money as Extra Choice and Fancy Georgias. If, however, we could produce cotton with staple of $1\frac{3}{8}$ inches which would not show a spinning loss of more than 25 per cent as compared with 33 per cent, the present average loss, and if at the same time we could grow a cotton with fewer neps, there would be a tremendous expansion in the demand for this style of cotton, for the reason that it is slightly stronger than Jannovitch; but as the case stands now Jannovitch is preferred at an even price in many cases on account of its being less wasty and having fewer neps.

The Egyptian, although closely related to Sea Island cotton, can not be grown successfully in our southeastern States on account of its susceptibility to the bacterial disease "black-arm."

Sea Island cotton produced in the West Indies is equal to the average American product, and indeed competes with the Carolina Sea Island cotton rather than with the interior product. The West Indian industry is new, having been developed mainly since 1902, and is as yet of small proportions, only about 4,000 bales per annum being produced; but the industry there may grow rapidly. It has already led the South Carolina planters to organize in refusing to sell seed.

The Sea Island grower will therefore recognize that the prices of his crop depend on several factors and that quality is more important than quantity. Organized efforts should be made to raise the standard of length and preparation in order to avoid competition with cheaper cotton. Of the better grades a larger quantity can be sold than is now produced.

Interior planters are advised not to aim to produce an extra long cotton. South Carolina and the West Indies can excel in this, and the market for such cotton is very limited. Furthermore, the increase in length is obtained at a sacrifice in yield which cancels the profit. Rather let the interior grower select for a staple $1\frac{3}{8}$ inches to $1\frac{3}{4}$ inches long and for a vigorous and productive plant, and let the campaign for a reduction of acreage be directed against staples less than $1\frac{5}{8}$ inches in length and against the planting of Upland cotton in Sea Island districts.

FARM PRACTICES.

On the Carolina Sea Islands the planters have worked out a system well adapted to the peculiar needs of that section. Their methods are in many respects excellent, and the recommendations in this bulletin regarding improvements apply less to these growers than to those in Georgia and Florida, where a brief survey will convince one that far greater profits could be secured by radical changes in farm practices.

SEED SELECTION THE FIRST REQUIREMENT.

Without seed selection Sea Island cotton can not be grown successfully for more than a few years in any latitude. The interior growers have always depended on the skillful seed selection of the Carolina planters and have continued to neglect the matter since this seed supply has been cut off by a growers' organization. No more improved seed can be had from the Sea Islands, and nothing is more certain than that the crop will continue to deteriorate rapidly until the interior growers begin work to improve it. They undoubtedly will rise to the occasion when they realize that their industry is at stake. They may be assured in advance that they will succeed to a degree limited only by the care and skill they expend.

Three points are to be sought by selection, as follows:

(1) Length and quality of staple must be maintained. Only by saving seed from plants having a long, fine, and uniform staple can these qualities be retained. Otherwise there occur in the fields an increasing number of plants with a shorter staple, due to the inherent tendency of this highly improved crop to revert to its original character. The farmer overcomes this tendency when he chooses his seed each year only from stalks that have maintained the desired quality.

(2) Good productive plants must be secured. A greater loss than farmers realize is due to the number of unproductive plants in every field. Even plants equally supplied with space and food differ much in the number of bolls they bear, the size of the bolls, and the way they open. These differences are mainly inherited, so that by careful attention to this point when selecting seed the producing power of any variety can be greatly increased.

(3) Run-out and hybrid plants must be eliminated. A conspicuous source of loss in the average interior field is the number of tall hybrid and run-out plants. These occupy double the space of good ones and yet produce a worthless crop. All such plants should be pulled out as soon as detected. Where careful seed selection is practiced and the neighborhood of Upland cotton avoided, very few of these undesirable plants will appear in the crop.

PREPARATION OF THE STAPLE FOR MARKET.

Next in importance to seed selection is the preparation of the staple for the market. Interior-grown Sea Island cotton has an unenviable reputation for poor preparation as compared with the Carolina Sea Island product. The farmers seem not to consider the delicate nature of the staple and handle it as carelessly as they would Upland varieties, whereas it requires special care at every stage from boll to bale. Too often it diminishes in value by exposure to weather in the field, by being mingled with broken leaves and yellow cotton in picking, by being stored undried when gathered damp, or by careless ginning. The luster of the staple once lost can never be regained. The admixture of weak and stained cotton means loss to the spinner from waste and the extra cost of cleaning, and this loss must be made good by a reduction in the price paid the farmer.

There is much complaint from the spinners of an undue amount of nep, or white knots of tangled fibers in cotton from diseased plants, or in cotton picked too green or not properly ginned. Much of this trouble can be avoided.

BETTER CULTURE MEANS LARGER CROPS.

The fact that the yield on some farms averages 400 pounds of lint per acre while the general average is perhaps less than 100 pounds per acre shows that there can be a great improvement in methods of growing the crop. The Sea Island cotton belt needs to diversify, to rotate crops, to use fertilizers more rationally, to build up the thin soil, to plow deeper and cultivate shallower, and to economize hand labor by modern farm machinery.

CREDIT AND THE RENTAL SYSTEM A BAR TO PROGRESS.

The cost of cotton production is greatly increased by the prevailing credit system, owing to the higher cost of supplies and the reduction of the farmers' ambition and efficiency. The rapid change from credit to a cash system now going on is a great gain for good farming.

The common practice of renting land for a share of the crop greatly hinders the adoption of improved methods. It means instead the continuous planting of cotton without attention to seed selection or soil improvement. When the owner can not operate his farm himself, he should retain strict oversight over the work done by his tenant and provide, through a written contract, for a specified system of rotation and seed selection.

If the period of rental were three or five years instead of one, there would be more incentive for the tenant to build up the soil. The owner who keeps his land in a high state of cultivation has no difficulty in securing the best class of tenants.

DEFECTS IN MARKET CONDITIONS.

There is a tendency among cotton buyers to pay an average price for all grades of Sea Island cotton, especially in the smaller markets. This means that good cotton brings less than its value, and inferior or dirty cotton too much. This practice is an injustice to the farmer who produces a superior article and it tends to discourage him from selecting for quality. Unless buyers are willing to pay full value for the best cotton, farmers can not be expected to improve their seed in any respect except to secure larger yields per acre.

It is an advantage to the farmer who has a superior grade of cotton to secure competitive offers from large buyers before selling. In this direction much good can be done by farmers' organizations.

CULTIVATION OF SEA ISLAND COTTON.

ROTATION AND DIVERSIFICATION.

Although Sea Island cotton always has been grown on the one-crop plan even on the Sea Islands, there are many reasons why greater success can be had by making it a part of a system of diversi-

fied farming. By rotation of crops several purposes are accomplished, as follows:

(1) The productive capacity of the land is increased and maintained. The cultivation of cowpeas, velvet beans, and other legumes adds to the soil large quantities of nitrogen drawn from the air, enabling the farmer to secure at slight expense an element which is the most costly part of purchased fertilizers.

The physical condition of the soil is improved, especially by the addition of humus or vegetable mold, whereas continued cultivation in cotton or corn rapidly exhausts the humus. The importance of humus can hardly be overestimated. A soil rich in organic matter is more easily cultivated than other soil. It suffers less from washing because the water is absorbed, and because of this water-holding power it does not quickly become too wet, nor does it dry quickly; hence, injury from drought is lessened. A soil rich in organic matter is richer in the beneficial bacteria and other organisms that take part in rendering available to the plant the food hitherto locked up.

By rotation, crops with different fertility requirements are alternated so that the same elements are not drawn on so constantly. Cover crops which increase humus can succeed cultivated crops which exhaust it, and in the intervals of rotation any poisonous or injurious excretion from the roots of a crop is neutralized. Deep-rooted crops may be employed to bring up plant food from the subsoil and leave it at the surface when they decay, where it will be available for shallower rooted crops.

The test of successful farming is to produce large and profitable crops and at the same time to build up the fertility of the soil, making it each year more productive. Diversified farming permits this to be done; continuous cotton growing never will.

(2) A diversified cropping system places farm operations on a safer and more economical basis. Regular and continuous employment for labor is secured if crops are grown which require attention at different seasons. The danger of loss from unfavorable weather or glutted markets is much diminished when several crops are grown. It is particularly important that the growers of Sea Island cotton should begin at once to practice diversification in order to gain experience with other crops, because there is a possibility that the invasion of the boll weevil into the eastern States may in a few years make Sea Island cotton an unprofitable crop. Much hardship will result unless other crops are established meantime.

(3) Rotation of crops is one of the most effective means of controlling weeds, insects, and plant diseases. Crab-grass, nut-grass, and other weeds troublesome in cotton fields are reduced in numbers by the shading and smothering effect of a heavy growth of cowpeas or velvet beans. Most injurious insects and plant diseases attack only

one kind of plant. The continuous culture of any crop affords ideal conditions for the multiplication of its pests, while rotation of crops results in their destruction from lack of food.

For example, the nematode worm, causing the destructive root-knot of peaches, cotton, etc., is greatly increased by planting susceptible crops, but can be controlled by a succession of immune crops, such as corn, oats, velvet beans, or peanuts. For several cotton diseases, including anthracnose, boll-rot, and "black-arm," rotation is advised as one of several preventive measures.

Rotation Systems.

The term "rotation" implies a prearranged order of succession for the various crops cultivated. Every farmer should draw up a planting scheme for his farm, worked out with reference to the relation of each crop to the others. The details of this plan will differ in every case according to the number of crops and the acreage of each, but some general principles apply to all.

The crops in a rotation may be divided into two classes:

(1) Money crops, in the majority of cases Sea Island cotton or corn, from the sale of which the principal income is derived. These draw from the soil more than they add to it.

(2) Improvement crops, grown mainly to build up the soil. These are usually legumes, like cowpeas, velvet beans, peanuts, or beggar-weed. If fed to stock they will return a revenue and improve the soil as well.

The choice of a legume.—Cowpeas have always been the most popular and widely grown crop of this class. They have many advantages over the others—adaptability to poor land, ease of culture, the value of the peas as food for man or stock, excellence as a hay crop, etc. On the other hand, they are open to the serious objection that they are very subject to root-knot and greatly increase this disease. On land infected by cotton wilt or black-root the loss is increased by the presence of root-knot. Fortunately the Iron cowpea is immune to root-knot and can be used with safety. In fields where it is certain there is no root-knot any pea can be planted, but the trouble is that root-knot frequently appears where its presence was not suspected. As all Sea Island cotton lands are sandy and subject to infection by root-knot and wilt it is urged that no other cowpea than the Iron variety be used in rotation with Sea Island cotton.

Velvet beans are a great addition to the resources of Sea Island cotton growers. They are entirely immune to root-knot and black-root and of much value in rotations for this reason. No other legume grown in the Sea Island cotton belt makes as much growth or adds as much vegetable matter and nitrogen to the soil. Velvet beans

afford excellent grazing for stock in late fall and winter, and should be grown much more than at present. Their long season of growth is a disadvantage when a catch crop is needed to follow potatoes or grain. The vines are so long that harvesting for hay is nearly impossible.

Peanuts, or ground peas, are also free from root-knot, and are especially useful as feed for hogs. They appear to be somewhat less effective as soil improvers than cowpeas.

Beggarweed is native to Florida and seeds itself whenever permitted to grow. It makes a valuable hay when cut at the beginning of the blooming season and does good service in enriching the soil. In the cotton field it must be kept under control by thorough cultivation or the seeds will become tangled in the cotton, but if allowed to spring up late in summer it will serve as a winter cover crop to the great benefit of the land. The complete immunity of beggarweed to root-knot is an important point in its favor.

Resting land.—A practice common on the Sea Islands and in portions of Florida is to plant cotton alternately on half the farm, leaving the other half to grow up in grass and weeds. This is much better than continuous cotton planting, but is a defective system because the maximum capacity of the land is not obtained. It is better to grow a useful legume than coarse or obnoxious weeds, like fennel, coffeeweed, and sandspurs, or if pasture is needed rye may be sown between the cotton rows in the fall, grazed during the spring months, then plowed under and Iron cowpeas sown for hay or for fall grazing. Thus there may be substituted a two-year rotation, which is perhaps the most practicable plan for the conditions now prevailing. The two-year rotation in its simplest form is cotton on half the land and corn and Iron cowpeas on the other half, the cotton following the corn and peas each year. A better plan is to plant one-half of the land in cotton, one-fourth in corn and Iron cowpeas, and one-fourth in velvet beans, reversing the order so that velvet beans come on the same land once in four years, cotton twice, and corn and peas once. This is practically a four-year rotation. If, after this has been repeated several times, the land becomes too rich in nitrogen, as indicated by an excessive growth of the cotton to weed, the velvet beans could be omitted for a year or two. Velvet beans or cowpeas in these rotations should be fertilized with about 200 pounds of acid phosphate and potash to the acre. No nitrogen is required.

A three-year rotation is better than one of two years. The three-year rotation for the first year might consist of rye, oats, or wheat for hay, followed by Iron cowpeas; second year, corn with Iron cowpeas; third year, cotton. Cut the corn when ripe and shred the stalks. Do not waste time pulling fodder. Cut the peas for hay or

pasture them. In early fall plow under the stubble and sow rye, oats, or wheat. This grain should be cut for hay just before it ripens, and should be off in time to plant velvet beans, if they are preferred to cowpeas. The field should be grazed during the fall, and the remaining litter plowed in early enough in the winter to decay before the cotton is planted. The advantage of the three-year rotation is that it permits keeping more live stock and will consequently improve the land more rapidly.

FERTILIZERS FOR SEA ISLAND COTTON.

PRESENT PRACTICES.

The character of the fertilizers and the amounts used per acre by farmers in different parts of the Sea Island cotton belt vary between wide extremes. The practices on the Sea Islands are characterized by heavy applications of home-mixed fertilizers, differing considerably in composition according to the ideas of the various planters, but usually rich in potash. The need for humus is recognized, and is supplied by growing cowpeas and by heavy applications of marsh mud, salt water grass, and compost. Three typical examples follow: (1) Two hundred pounds of kainit, 200 pounds of acid phosphate, 400 pounds of cotton-seed meal, 25 bushels of Sea Island cotton seed, 25 loads of marsh mud per acre; (2) 200 pounds of kainit, 200 pounds of acid phosphate, 200 pounds of lime, 1,000 pounds of Sea Island cotton seed per acre; (3) 300 pounds of kainit, 300 pounds of acid phosphate, 300 pounds of cotton-seed meal per acre.

In Georgia and Florida, on the other hand, light applications predominate. Occasionally, however, a farmer goes to the other extreme and puts on 1,000 to 2,000 pounds of fertilizer per acre. A common practice is to use a complete fertilizer of the 2-8-2 grade,^a applying 100 to 250 pounds per acre. Some planters, however, use only acid phosphate and potash, while others use nothing but kainit.

GENERAL PRINCIPLES GOVERNING THE USE OF FERTILIZERS.

The fertilizer question is too complex to discuss fully here. Farmers' Bulletins Nos. 44 and 48 contain detailed information on this subject, and will be sent free of charge to any person requesting them. A few general rules to be remembered are the following:

(1) The best results from the use of fertilizers can be had only when the soil has been put in first-class physical condition by deep plowing and the addition of vegetable matter.

(2) Stable manure and compost made on the farm are cheaper and far more effective and lasting than commercial fertilizers.

^a This means that the fertilizer contains 2 per cent of ammonia, 8 per cent of phosphoric acid, and 2 per cent of potash.

(3) The market value of commercial fertilizers is based on the nitrogen, potassium, and phosphorus they contain. The farmer should buy only the quantity of each element that will give the most profit on his soil.

(4) The amount of each element required varies with the soil so much that two sides of the same field often require different fertilizing.

(5) The proper fertilizer formula can not be told from a chemical analysis of the soil or of the plant, but an opinion can be formed from the appearance of the crop and verified by field trials.

(6) More plant food can be purchased for a given sum in high-grade fertilizers than in low-grade brands. Buy the best and use less per acre.

Effect of Nitrogen.

Sea Island cotton requires less nitrogen than most crops, especially on low or moist soils. All excess of this element stimulates vegetative development, resulting in tall, coarse, and relatively unproductive plants, with large, dark-green leaves. A lack of nitrogen is shown when plants are small, with a light yellowish-green cast of foliage.

The usual sources of nitrogen, or ammonia, are cotton-seed meal, dried blood, tankage, fish scrap, nitrate of soda, and sulphate of ammonia. It is the most expensive ingredient of fertilizers, costing 16 to 18 cents per pound as compared with 4 to 5 cents for potash and phosphoric acid, and for that reason should be supplied mainly by rotation with legumes. The effect of cowpea or velvet bean stubble plowed under at the Alabama Agricultural Experiment Station was to increase the next year's cotton crop 63 per cent, this figure being the average of four tests. In such cases it is often unnecessary to purchase nitrogen, except that it may be profitable to apply about 50 pounds of nitrate of soda before planting to stimulate the young seedlings to rapid growth. When commercial fertilizers are relied on, the nitrogen is best derived from cotton-seed meal or other organic materials, such as tankage or dried blood, which become available more slowly and are more lasting in their effects than the quickly soluble nitrate of soda or sulphate of ammonia. An exception should be made in the case of land subject to the blue disease, as stable manure or other organic fertilizers, unless very thoroughly decayed, aggravate this trouble. (See page 48.)

Effect of Potassium.

A liberal supply of potash is very important for Sea Island cotton, and farmers outside of the Sea Islands use too little of it. Potassium influences the formation of starches and sugars in the plant and appears to be indispensable for protein formation. A lack of it in the

case of Sea Island cotton may lead to the appearance of "rust," a disease resulting from disordered nutrition. Fields or parts of fields known to be subject to rust should receive an additional application of potash in amounts varying in accordance with the severity of the disease (see page 48). Kainit is the most common source of potash, but as it contains only 12 per cent of potash it should be applied liberally. Muriate of potash containing 48 per cent of potash is more convenient on account of its concentration and is usually considered to be proportionately effective. Fifty pounds of muriate of potash per acre would thus be equivalent to 200 pounds of kainit.

Effect of Phosphorus.

This element in the form of phosphoric acid compounds is indispensable to the Sea Island cotton plant for its general development, and especially for the seed and lint. Most soils are deficient in phosphorus, which is therefore an important ingredient of fertilizers. Acid phosphate is the usual source, and on account of its low price forms an unduly large proportion of the average fertilizer.

Lime Usually Unnecessary.

With the exception of occasional applications of marl on the Sea Islands, lime is not used by cotton growers and there is little evidence that it would be profitable.

The Best Formula.

From the foregoing it will be understood that no fertilizer formula can be given that will fit all cases. The following is suggested, subject to modifications as the conditions vary: Nitrogen, 3 per cent; acid phosphate, 8 per cent; potash, 4 per cent. A ton of fertilizer having approximately this composition could be made from acid phosphate, 1,050 pounds; cotton-seed meal, 750 pounds; nitrate of soda, 62 pounds; muriate of potash, 138 pounds. The potash should be increased on land liable to rust, and the nitrogen increased or diminished according to the size of weeds the land will produce.

Quantity to the Acre.

The aim may well be to apply the maximum quantity of fertilizer that will return a sure profit. This will vary according to circumstances and can be determined only by experiments made on each farm. Two hundred pounds per acre is too little in almost every case, and if more than 1,000 pounds per acre are applied some of the fertilizer is likely to be wasted, particularly on thin land. The better the soil in tilth and the richer in humus the more fertilizer can be used.

Methods of Application.

Where less than 400 pounds of fertilizer per acre are used, it is probably best to apply all in the drill at the time of planting. For larger quantities many farmers prefer to divide the application, putting part in at the time of planting and the remainder during cultivation in June.

PREPARATION OF THE LAND.

Thorough clearing of the land, including the removal of all stumps, is essential for the use of modern plows and cultivators. The next requirement is drainage. If the land is wet or subject to overflow, it must be drained. This can be done by open ditches, but tiles are better. Farmers' Bulletin No. 187, on this subject, will be sent upon request. Many planters on the Sea Islands have greatly increased the producing capacity of their fields by drainage and have also much reduced the danger of loss from excessive rains.

RIDGE CULTURE.

On the Sea Islands cotton is invariably grown on ridges, or beds, 5 feet apart, as indicated in the accompanying diagram (fig. 4). The method of forming and handling these beds is briefly as follows: Beginning in January the old stalks are broken down, the limbs and trash



FIG. 4.—Cross section of the beds on which cotton is grown on the Sea Islands.

raked into the alleys, and the coarser litter burned. In February cotton seed is strewn in the alleys at the rate of 1,000 pounds to the acre, and a compost of stable manure, pine straw, marsh grass, and other refuse applied to as much of the field as the quantity obtainable permits, giving preference to the poorer portions. With a two-horse plow a furrow is turned in from each side to cover the compost and seed. In late February or in March the commercial fertilizer is drilled in at the rate of 600 to 1,000 pounds per acre and covered. The beds are rolled with a double roller (see fig. 5) before planting. Strips of wood on these rollers mark the position of the hills. Planting is usually done by hand, sometimes with a planter. When the cotton is well up it is cultivated with a sweep and hoed by hand, the dirt being drawn around the plant. Cultivations and hoeings alternate. The cotton is worked every week—eight to ten times in all. Thinning begins when the plants are 5 to 6 inches high and is done gradually until only one plant is left in a hill. The cotton is laid by in July or August, when it becomes too large to work without injury. The plants are then growing on broad beds separated by alleys about a foot deep.

While level culture is generally practiced in Georgia and Florida at the present time, it is quite likely that a modification of the South Carolina broad bed would be more profitable. This ridge system gives better results in two classes of cases, as follows:

(1) On low and poorly drained land, where it permits greater root development on account of the improved aeration of the soil.

(2) When, on account of the land being rich and well fertilized, Sea Island cotton grows too much to weed under level culture. In such cases the grower is compelled to adopt measures to turn the energies of the plant from vegetative growth to fruiting. This is done by restricting the root development, (1) by maintaining a compact subsoil, which the Sea Island planters accomplish on their



Fig. 5.—Double roller used on the Sea Islands to prepare the beds for planting cotton. The strips of wood mark the location of the hills.

deep sandy soils by pasturing with cattle during the year of rest; (2) by regulating the moisture supply by the high beds, and (3) by root pruning by deep cultivation if the cotton needs it. It is also believed by the Sea Island planters that ridge culture permits better control of nut-

grass, as this pest can be kept down more successfully by covering it with earth than by cutting it up.

The ridge system has its limitations and disadvantages, which must be borne in mind. It will not do for light and droughty soils deficient in vegetable matter and scantily fertilized, where the cotton plants would suffer from lack of moisture. Such soils should first be built up by a course of green manuring. The greatest disadvantage of the ridge system is the increased cost of cultivation due to the hand labor required to draw the earth around the plants. This objection can and must be met by the introduction of improved implements for cultivating which will work the beds without hand labor.

Interior farmers are advised to test the ridge method thoroughly after carefully studying the subject and adapting it to their conditions.

LEVEL CULTURE.

If level culture is preferred, the following instructions will apply:

Plowing should be Deep.

It is advised that the land be broken broadcast, with a two-horse plow, 6 to 8 inches deep, or as deep as practicable under the circumstances. In very shallow soils only an inch or so of the subsoil should be turned up at once, but by plowing an inch deeper each year such a soil can be deepened. Subsoiling has its advocates and may be profitable in some cases, but for the average Sea Island soil it is not recommended. If practiced at all, it should be for the corn or other crop preceding cotton in the rotation.

Vegetable Matter should be Plowed In.

All vegetable matter on the land and all that can be put on it should be plowed under in early winter, when it will have time to decay. The remains of a velvet bean crop, or grass, weeds, corn-stalks, etc., all greatly improve the land.

The common practice of burning over land before plowing can not be too strongly condemned. It means the deliberate destruction of fertility worth more than the farmer can afford to purchase and the loss of the humus that should be conserved by every possible means. An exception to this rule should be made if boll-rot or black-arm has been troublesome. Diseased stalks should be burned to prevent the infection of the next crop.

Fertilizing and Bedding.

Having broken the land broadcast, apply the fertilizer with a fertilizer distributor in drills the proper distance apart. Bed over this with a disk harrow or with plows in the usual way.

Planting.

Plant with a good machine, preferably one that will drop the seed in hills at the desired distance, and thus save labor in chopping to a stand. A good distance for average conditions is 20 inches apart in 5-foot rows. The plants should finally be thinned to one in a hill. One plant every 20 inches will bear more cotton than two in the same space. It is furthermore very difficult to judge the plants properly when selecting seed if two plants grow in the same hill.

Time of planting.—It is advised that planting be begun as early as the season permits. This varies in different years and sections from March 15 to April 10. Early planted Sea Island cotton is found to make a more compact and fruitful plant, while late cotton tends to form a larger and coarser weed.

Long experience is required to judge truly the best time for planting, for the southern spring is variable and uncertain. On the one hand the cotton must escape frost, and on the other the spring droughts. Should dry weather prevail before planting is completed, the seed should not be put into the ground until there is ample moisture to bring it up, as otherwise it is likely to perish. Soon after the cotton comes up replant all missing hills. Every effort must be made to obtain a perfect stand. Every missing hill reduces the crop, while the cost of cultivation is the same as for a full stand.

Cultivation.

With level culture a weeder can be used to advantage for the first cultivation and at weekly intervals until the plants are too large. It must be used frequently, as it will not eradicate large weeds. Cultivation in general should be frequent and shallow. Cultivate deep only when the cotton is growing too fast and it is desired to stimulate fruiting. Economize labor by using cultivators rather than sweeps. Work the land as soon as dry enough after each rain, aiming to preserve a shallow dust mulch to conserve moisture. Never plow or cultivate when the land is wet. Lay by the cotton only when it is too large to cultivate without injury.

SEED SELECTION.

The high quality of Sea Island cotton to-day is due to the careful seed selection that has long been practiced on the Carolina Sea Islands. Seed selection is therefore a feature of prime importance, the keystone of the arch. To realize its influence on the industry one must trace its history from the beginning.

ORIGIN OF SEA ISLAND COTTON.

As indicated by its botanical name, *Gossypium barbadense*, the original home of the plant is thought to have been the West Indies. When first introduced into the mainland of America, about 1786, it is reported to have been considerably different from the present form. The plant was a perennial—larger, later, and less productive than now. The method of culture described on page 23 was adopted to reduce the size of the plant and stimulate fruitfulness, but the great change that has been wrought is due mainly to careful breeding. Through several generations the planters have selected seed from the earliest, most compact, and most productive plants, with the longest and finest staple, until the character of the plant has been radically changed.

CONTINUED BREEDING NECESSARY.

The cotton plant has become variable, enabling the breeder to select finer forms and to raise the standard of the crop far above its natural

level. By reason of this variability, seed selection must be continued to prevent deterioration, for there is no standing still. The upward movement must be continued by perpetuating the finer types desired by the cultivator, or, if neglected, the inferior plants will increase rapidly in the crop and the cotton will tend to revert to its original type.

Sea Island Methods.

There has been developed on the Sea Islands a well-defined and uniform system of selection. It is based on the correct idea—that of discovering the best individual plant and preserving its offspring. A number of superior plants are marked and carefully compared in the field, then picked separately and the seed cotton critically examined. The best plant is retained and the seeds planted in a plot by themselves, one or two in a hill, making perhaps 500 plants in all. If this plot retains the good qualities of the parent plant the cotton is picked and the seed again planted separately, making a 5-acre plot the third year. The fourth year there will be seed enough to plant the whole crop, all descended from the single stalk first chosen. A new individual plant is selected every year, so that a fresh supply of seed is always being grown. Seed from the general crop is considered less desirable for planting at home and was formerly sold to Georgia or Florida growers.

Sea Island Varieties.

A number of planters on the Sea Islands have been practicing this system of seed selection for many years. Each man has his own ideals respecting the best form of plant and the most profitable length of staple and selects a type conforming most closely to this ideal. There have thus been developed a number of distinct varieties of Sea Island cotton, which differ in length and quality of staple, form of plant, size and appearance of seed, percentage of lint, and other features. They are not given varietal names as much as in the case of other cultivated crops, but when offered for sale are known by the name of the breeder, as Hinson, Seabrook, Rivers, La Roche, etc. These names have not been preserved when seed has been sold to interior points and there is consequently much confusion in the matter of varietal names.

Varieties of Sea Island cotton are constantly changing. Each breeder renews his stock annually and in doing so may propagate from a plant differing from his old type, in which case his entire crop four years hence would be influenced.

Breeders' rights.—Many of the Sea Island varieties, particularly the finer ones, are considered the personal property of the originator, who will not part with any of his seed, even to his neighbors. To

do so would be likely to result in an overproduction of that particular staple and a lowering of prices, as the market demand for the higher-priced staples is exceedingly limited. Furthermore, the breeder is as much entitled to reward for his labors as the inventor of a new machine is to patent rights. A strain of fine cotton is the product of many years of careful selection and could not be duplicated without long-continued work requiring much skill and care.

Sale of seed from the Sea Islands.—On the Sea Islands the growers of medium staples, for which there is a larger market than for the finer product, have for many years sold their seed, both at home and to buyers in Georgia, Florida, and foreign countries. In 1904, however, West Indian competition stimulated the formation of an association to prevent the sale of seed outside the Sea Islands, and at the present date this embargo is still in force. The right of these growers to dispose of their product as they see fit is not questioned. Their action, however, will have great influence on the interior sections, which have always depended on Sea Island seed. Georgia and Florida produce eight-ninths of the American crop, but because of total neglect of seed selection deterioration has been rapid there, requiring renewal of seed every few years.

Seed Selection will Succeed in the Interior.

Thrown on their own resources, the interior growers will find that they can grow their own seed and maintain a satisfactory quality. The success of the Carolina planters is due to their methods more than to their soil and climate. There are already men in Georgia and Florida who have maintained the quality of their cotton for fifteen years or more by selection without renewal from the Sea Islands. In fact, it should be possible to produce a variety better fitted for interior conditions than any imported seed, for adaptation to climate and soil can be secured together with greater productiveness.

METHODS OF SELECTION.

The amount of gain from seed selection will depend mainly on the method employed; the more care taken, the better will be the results. If any farmer is so situated that he can not select his own seed, let him at least obtain seed for planting from the middle picking in a field of known good quality, or purchase from some near-by seed breeder. He should not risk an entire season's labor by planting seeds of unknown value taken at random from a public gin.

Three methods of selection will be described. Under varying circumstances all of them may well be employed.

Roguing.

The simplest method of selection is called "roguing," because it involves merely the removal of inferior or varying plants, called

"rogues" by seedsmen. This practice will serve to lessen deterioration in a variety already of satisfactory quality, but will not effect a very rapid improvement. Every grower of Sea Island cotton should destroy all hybrid and "run-out" stalks whenever observed. The hybrid plants are the results of crossing between Sea Island and Upland varieties, or between Sea Island and other hybrids. They are the tall stalks, often called "male stalks" or "bull cotton," which are quite common in the average interior field. They do harm in three ways: (1) On account of their great size and vigor, one of them takes up as much room in the field as two good plants; (2) they bear

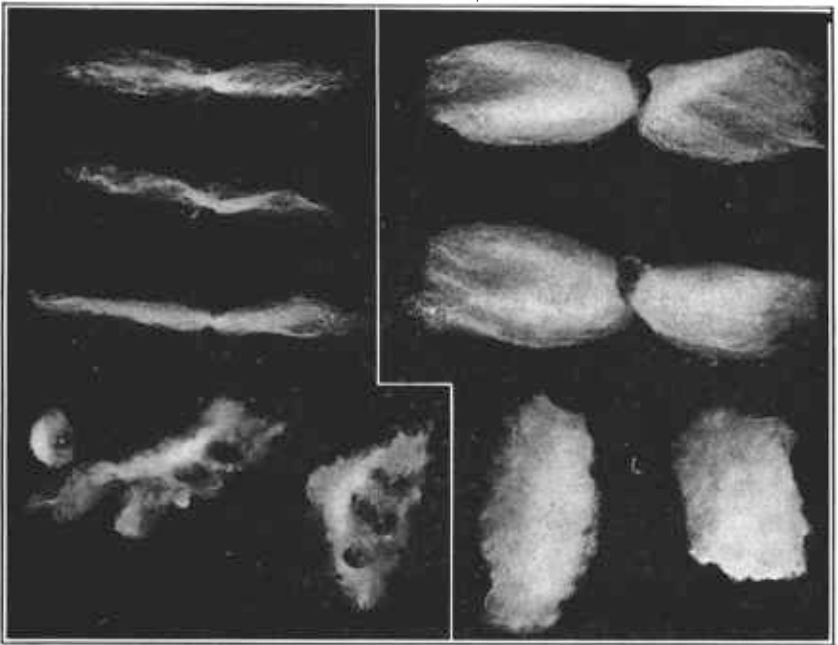


FIG. 6.—Good seed cotton at the right compared with a "run-out" form at the left. The lower figures are the locks as picked. The upper figures are seeds with the fibers straightened out.

a scanty crop which is so inferior that it reduces the price of the whole crop when detected in the sample; and (3) every seed from one of these plants produces a hybrid plant the following year.

"Run-out" plants are pure Sea Island stalks which have deteriorated until the staple is short and too scanty to cover the seed. (Fig. 6.) They can not be detected until the bolls begin to open, when it is best to pull them out, as the crop they will bear has no value and only lowers the quality of the rest of the crop.

General Selection.

A simple method of improving seed is to pick from the best plants in the field enough to plant the next crop, or to select with still more

care a smaller quantity to plant a seed plat of 3 or 4 acres to grow seed for the general planting the following year. The selection of the seed is best done by the farmer himself, assisted by two careful pickers. Select from the middle picking before the main crop is gathered. Search through the whole field for the best and most productive plants. Before directing the pickers to pick a plant, examine the staple and reject every plant with lint less than $1\frac{1}{2}$ inches long. It would be a vital error to select without regard for length of staple, because plants with wide-opening bolls would then be chosen and this quality is often accompanied by a short staple. Gin this selected cotton separately on a clean gin.

This method of selection can easily be followed by every farmer and will produce good results, though not equal to the next plan described.

Pedigree Breeding.

Pedigree breeding, while requiring more careful attention than the methods already described, will effect the greatest improvement in the least time and should be followed by all who undertake the production of improved seed for sale. It is substantially the same as the plan followed by the planters on the Carolina Sea Islands, where no other method would maintain such a high quality. All progressive farmers would profit by adopting this system.

The fundamental principle is to breed from a single plant of exceptional merit, which must also prove its ability to transmit its good qualities through its seed to its progeny. Instead of planting mixed seed taken from a large number of good plants, as in the preceding method, the choice is narrowed first to a few plants, which are compared not only as to productiveness, length and quality of staple, etc., but also with regard to their prepotency and the uniformity of their offspring, as determined by a planting test the following year, until finally the progeny of the best individual is chosen. The seed thus obtained is increased as rapidly as possible until enough is secured to plant the whole crop.

A similar method is practiced by successful breeders of other crops, as, for example, in the "ear-row" plan of improving corn now so generally followed in this country. Plant breeders agree that too much stress can not be laid on the importance of searching for the exceptional individuals that may have great potential value for crop improvement. The best varieties of all our cultivated crops whose history is known came originally from a single plant or tree of unusual merit discovered by some observing grower.

Beginning the selection.—It is assumed that the farmer who desires to improve his cotton has already planted a field from the best obtainable seed and has pulled out all objectionable hybrid or "run-out"

stalks. He should begin to make selections as soon as the first bolls open. Choose the plants having a long staple and in other respects conforming to the ideals described. Mark these plants with a white cloth and a tag bearing a number. It is advisable also to set a tall stake by each selected plant so that it can be found more readily. Pick each separately and at the end of the season spread on a table and compare the various lots critically and at leisure with regard both for length and fineness of staple and for yield. Discard the inferior ones until from ten to twenty-five are left. These are to be further tested by planting the second year to discover the prepotency or transmitting power of each.

Second year: The progeny test.—Plant the seeds from the selected plants in adjoining rows, keeping each lot separate. These small lots can be planted in the lint, provided care is taken not to cover them very deep. Select ground adapted to cotton and have it well prepared. Plant with care, dropping only two seeds to the hill. If possible, have 100 hills to the row. The location should be as far from other cotton as possible to lessen the crossing. Isolation can usually be secured by planting the seed plat in the section of the farm used that year for other crops—in the middle of a cornfield, for instance. If it is necessary to plant near other cotton, plant a wide border of the same variety around the breeding plot. By all means avoid proximity to Upland cotton, which is the most serious factor in the deterioration of inferior Sea Island cotton.

The object of this planting is to determine the relative merit of the different selections, and particularly their uniformity. The general excellence of the plants in each row should be considered—their vigor, productiveness, and freedom from disease. Any row lacking uniformity to a marked degree should be eliminated from consideration. When the bolls open, compare the staple, length, fineness, and uniformity, and finally choose the row possessing the greatest merit. This is to be the beginning of the new strain. In this row mark and pick separately the best ten plants. (Fig. 7.) Pick together the remaining plants in the row. The other rows in the plat, although not retained for breeding, ought to be better than unselected seed and may be used for planting the general crop.

The desirability of this method of breeding will not be appreciated until it has been tried and the variations in the offspring of different plants observed. It is common to find one row with plants all alike possessing a staple longer than the average and also more productive, while another row may be widely variable in form of plant and quality of staple. Plants of superior merit often appear in the variable rows. They should not be saved, however, as the chances are that their offspring will be variable like the row in which they appear.

Third year: The increase plat.—The seed from the best row of the second year is to be planted in a small field to produce seed for planting the general crop. Any inferior plants that chance to appear in this field should be destroyed, but no other selection need be practiced, as it is not intended to plant this strain permanently, but to renew the seed annually from a new increase plat.

In addition to the increase plat, the progeny test is to be repeated, using the ten plants chosen from the best row and any others of exceptional merit that may be discovered in the general field. Select in the same manner as before the best row and the best plants therein.

Fourth year: The general crop.—In this year and each succeeding year the same process of selection is carried out. This should become a part of the regular farm practice, to be considered of equal im-

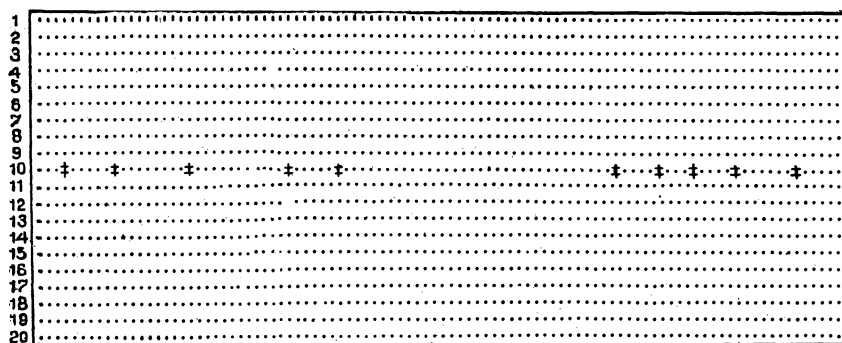


FIG. 7.—Diagram of a pedigree breeding plat. Row No. 10 has been selected and 10 plants in it marked to be saved separately.

portance with cultivating and fertilizing. The several stages under way from now on are as follows:

- (1) Selection of the finest plants.
- (2) Progeny test to determine uniformity and productiveness.
- (3) Increase plat.
- (4) General crop.

If seed from the general crop is to be sold, careful attention must be paid to removing tall hybrid or "run-out" stalks from the field whenever they are observed. Seed from the last picking had better be rejected, as the upper bolls do not mature their seed as well as the lower ones.

Separate ginning of the seed crop important.—Cotton from the breeding plats or from other fields intended for seed should be ginned separately and the gin and conveyors first thoroughly cleaned of foreign seed. The farmer should personally superintend the ginning of his selected seed, as a mistake at this stage might lose him the fruits of several years' work. Owners of ginneries should realize their opportunities and obligations in this direction and afford their patrons every facility for the separate ginning of selected seed cotton.

The sale of cotton in the seed is a hindrance to seed improvement, unless there is at the same time an organized movement for the distribution or sale of improved seed to the farmers.

Improvement of Cotton Seed by Gravity Separation.

It has been found possible to secure a marked gain in the percentage of germination and the vigor and productiveness of the cotton crop by removing the light weight and imperfect seed before planting. For example, in an experiment by the writer the heavy seed germinated 27 per cent better than unselected seed and 42 per cent better than light seed thrown out by the air blast.

The separation is effected by means of an air blast produced by a fanning mill modified for the purpose. All who handle considerable quantities of Sea Island cotton seed will find it profitable to use such an apparatus. Seed from which the unginmed locks and tufted seeds have thus been removed is much better adapted for use in cotton planters. Another very important gain in this process is the removal of the fuzzy seeds of Upland hybrids, which on account of their greater surface area are blown out with the light seed. Persons interested in the matter should write to the Secretary of Agriculture for Farmers' Bulletin No. 285, entitled "The Advantage of Planting Heavy Cotton Seed," by Webber and Boykin, which describes the method and apparatus fully. All ginneries should be equipped to treat in this way seed intended for planting.

IDEAL QUALITIES OF SEA ISLAND COTTON.

Length of Staple.

In Georgia and Florida the breeder should work for a staple not less than $1\frac{3}{8}$ inches or more than $1\frac{3}{4}$ inches in length. In South Carolina each planter is guided by his own preferences, some planters choosing the medium kinds on account of their greater productiveness and others finding it profitable to grow the extra fine and long varieties. Experience has shown, however, that these fine strains, having a staple 2 inches to $2\frac{1}{2}$ inches long and selling from the Sea Islands at 40 to 60 cents per pound, are not profitable in the interior. As compared with the medium sorts, they are less productive and more subject to disease, while the bolls are smaller and the cotton harder to pick. The fine staple requires more care in handling than the interior farmers are accustomed to give, and the interior markets will not pay as high prices as Charleston. In the past the best results in the interior have been obtained with strains classed on the Sea Islands as medium fine, such as Hinson and Seabrook.

To determine the length of staple from a sample of seed cotton, pull a lock apart and take a single seed and carefully straighten out the fibers with the fingers or a fine comb. Measure the length of the greatest number of fibers; then test several other seeds from the same plant.

Uniformity of Staple.

After determining the length, estimate the amount of shorter staple in the sample and discard plants having a portion of their staple either very long or too short. Uniformity is an important quality, as the spinner can not utilize the short fibers, which are combed out as waste.

Strength of Staple.

Pull a tuft of fibers until it breaks. Diseased plants show a marked weakness, and some healthy ones produce a weak staple and should be discarded.

Percentage of Lint to Seed.

This quality, or the "ginning average," is important, but farmers often lay too much emphasis on it, forgetting that it is the total yield of lint per acre that determines their profit.

The percentage of lint should be determined by ginning and weighing both lint and seed. The result is usually expressed in terms of the amount of seed cotton required to produce one pound of lint. To determine this, divide the weight of seed cotton by the weight of lint. To express the same in per cent, divide the weight of lint by the weight of seed cotton. Having the ginning rate, to reduce it to a percentage basis, divide 1 by it; for example, $3.33=30$ per cent. The per cent of lint varies considerably in different varieties of cotton, from 25 per cent, or 1 to 4, in extra fine Sea Island cottons to 39 per cent, or 1 to 2.56, in small-seeded Upland cotton. It varies among plants in the same field, and there is a marked variation in different seasons, the per cent of lint being higher in favorable seasons. Even with the same variety and the same season, differences in soil and culture influence the per cent of lint. For example, a consignment of Seabrook seed was divided among several farmers in 1904 by the A. P. Brantley Company of Blackshear, Ga. The ginning rates of the different crops produced from this seed varied from 3.96, or 25 per cent, to 3.10, or 32 per cent, the average of 41 fields being 3.42, or 29 per cent.

Color of Staple.

The staple should have a lustrous creamy tint in preference to a dead white. The color should be uniform, as mixtures of white and creamy cotton are not desired by the buyers.

Fineness.

Fineness depends on the diameter of the fibers, which can be measured exactly only with a microscope. An excellent opinion can be formed from the feeling of the cotton, if not too dry. Fineness is a very important quality to the spinner.

Productiveness.

Next to length of staple, productiveness is the most important quality. In making selections a preliminary estimate can be made by the eye or by counting the bolls. Sea Island planters estimate that every 15 bolls per plant equals 100 pounds of lint per acre under ordinary conditions. In breeding, the principal weight should be placed upon the yield from the progeny rows the second year of the selection. Strains derived from different plants in the same field have been found to vary greatly in productiveness, and careful selection will greatly improve any variety in this respect.

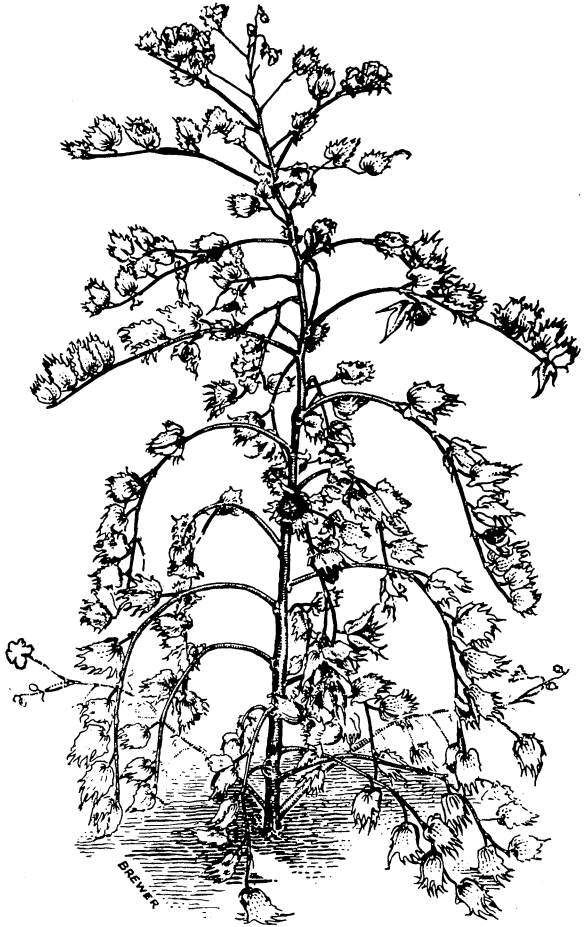


FIG. 8.—Ideal form of cotton plant. The leaves have been removed to show manner of branching.

Form and Size of Plant.

The plant should be compact, 4 to 6 feet high, with a strong central stalk and 2 to 4 well-fruited basal branches. Fruiting branches should occur at close intervals, 1 to 2 inches, and a habit of double bearing or producing an axillary branch at each node should be developed. All branches should be close jointed and bear a boll at every joint. (See fig. 8.)

Bolls.

The bolls should be large, long, and well filled to the end, not tapering too abruptly. As a rule a long boll indicates a long staple and a short or obtuse boll a shorter staple. The number of locks should be four. The majority of Sea Island bolls have but three. More than four locks, even if obtainable, would not add to the yield or to the convenience of picking. The bolls should open well, as such bolls ripen their cotton better and are far easier to pick. In making selections do not choose wide-opening bolls without examining the staple, as a wide-opening boll is usually correlated with short staple. If the size of the involucre, or "square," could be reduced by breeding, there would be less trouble from bits of dry leaf in the cotton at picking time.

Seed.

The seed should be small, but well filled, black, with a small green tuft at the end. A large, perfectly bare seed is correlated with a low ginning rate and a large, coarse plant, and is usually taken as an indication that the strain is running out. An excess of short fuzz is characteristic of some Sea Island varieties, but such cotton can not be ginned as rapidly as other kinds. Large seeds entirely covered with white or green fuzz indicate hybridization with Upland cotton, but occasionally occur in pure Sea Island cotton.

Earliness.

Very early varieties are usually less productive than later ones, while very late ones may be caught by frost before fully mature. A medium season of maturity is to be preferred.

Disease Resistance.

In some instances disease resistance may be a feature of fundamental importance, as when the land is infected with wilt. In such cases one of the disease-resistant varieties described on page 46 should be planted. In all selections attention should be paid to this point, particularly to secure resistance to black-arm and to anthracnose of the bolls.

HANDLING THE CROP.**PRESERVING THE FULL VALUE OF THE CROP.**

After devoting his best energies for a whole season to the production of a fine crop of cotton, the farmer must still continue his vigilant oversight until the staple has left his hands. Sea Island cotton is a fine and delicate product and there are many ways in which it may be injured and its value reduced. All defects in the cotton are ultimately charged to the farmer's account and reduce the price paid to him. If the spinner finds in a lot of Sea Island cotton 10 per cent

more waste than in Egyptian cotton available for the same purpose, he will manifestly be unable to pay as much by 10 per cent for the Sea Island. By a little care much of the present waste can be avoided; hence strict attention should be paid to these factors.

GRADE: DEFINITION AND IMPORTANCE.

In the cotton market the term "staple" refers to the length and fineness of the fiber, and these points are influenced most by seed selection.

The term "grade," on the other hand, indicates the appearance of the cotton as regards cleanliness and color, qualities influenced mainly by the manner in which the cotton has been handled. The price is considerably influenced by the grade.

Defects Influencing Grade.

(1) **Loss of bloom or luster.**—The best Sea Island staple has a gloss or luster which adds greatly to its beauty and is indispensable for certain kinds of fabrics. This bloom is destroyed by exposure to sun and storm when cotton is left long unpicked, and the staple then has a gray, lifeless appearance, sometimes termed "mildewed" or "weather-beaten." A similar effect is produced by picking cotton when wet with rain or dew and storing it in piles without first drying it in the sun.

To preserve the staple at its best, pick often—once a week, if possible—and expose the seed cotton to the sun to dry. This is done by spreading it in a shallow layer on a low roof or arbor, where it is turned frequently until so dry that the seed will crack between the teeth.

(2) **Loss of strength.**—The loss of luster is accompanied by a lessened strength, so that a staple originally good fails to make as strong thread as before—an added reason for better care. Very dry cotton is also not as strong as that which, under proper treatment, has retained its natural moisture.

(3) **Nep.**—Spinners designate as "nep" small white specks in the baled cotton, which they find very difficult to remove in spinning and which often go into the thread and appear in the completed fabric as white dots. These neps are in reality tangles in the fibers, which when viewed under a microscope are seen to be weak and undeveloped. They are due in part to picking cotton before maturity; a boll that is forced open to extract the lint is a source of nep, as the cotton in it does not get the necessary exposure to the sun to dry and straighten and strengthen the fiber. Other nep originates with weak cotton from diseased bolls or from any other cause that prevents the fibers from attaining full development. Such undeveloped staple comes from the gin full of nep. Poor ginning, however, by weakening and breaking

fibers increases loss from this cause. Pickers should be cautioned against picking unripe bolls. Thorough sunning will in part remedy the trouble, and good culture, by producing healthy plants, will do more.

(4) **Broken leaf, etc.**—The presence of fragments of leaf, weed seeds, and other foreign matter in the cotton reduces its grade. These are often difficult to avoid, particularly after storms, when bits of the dried square, or involucre, are often mingled with the cotton; but pickers should be watched and cautioned against picking dirty cotton. Fortunately, the spinners find it easier to remove this class of impurities than the nep previously mentioned.

(5) **Short fibers.**—A large part of the waste is due to short fibers, which have to be combed out. They originate in part in variations in the length of the staple on the seed, a serious fault, to be remedied by seed selection as discussed under uniformity (page 34.) Short fibers are in other cases due to imperfect ginning, which breaks or crimps the staple and may be avoided by better management.

(6) **Weak fibers.**—The greater part of the waste is due to the presence in the baled cotton of staple from undeveloped or diseased bolls. The bolls in such cases do not open and the fibers do not expand but remain matted together in a "hard lock" (fig. 9). All locks that do not open out after drying may be assumed to be worthless on account of weak and



FIG. 9.—Locks of Sea Island cotton from healthy bolls (at the top) compared with hard locks from diseased bolls (underneath).

undeveloped staple. Pickers should be instructed not to gather hard locks, and in the assorting after picking all remaining ones should be thrown out. Seed cotton still containing hard locks when it reaches the gin can be improved by setting the stripper bars well back from the roller to allow the locks to fall through. Close ginning is a mistake, for it costs the farmer more through deterioration of his cotton than he gains by the slight increase in weight.

The number of hard locks can be greatly reduced by bringing the cotton to perfect maturity through attention to fertilization and culture and to the control of diseases.

(7) **Lack of uniformity in the bale.**—Separate late from early pickings. Buyers desire to have each bale uniform within itself. If, therefore, a late picking is inferior to an earlier one, it should not

be ginned and packed with it, as the price of a bale is determined by the poorest cotton found in it after thorough sampling.

(8) **Yellow cotton.**—Buyers invariably complain when a sample of cotton contains yellow staple, and the grade and price are consequently reduced. Yellow tufts in the ginned cotton come from discolored locks that should have been left unpicked or been sorted out before ginning. They originate, as a rule, in bolls attacked by the anthracnose or bacterial boll-rot (see page 47). Their presence in a bale is an indication of too close ginning.

(9) **Sand.**—A bale of cotton always contains considerable sand which has been blown into the open bolls. This is quite unavoidable, but when cotton has been left unpicked and has blown out on the ground the quantity of dirt is increased.

(10) **Moisture.**—An element of waste from the spinner's standpoint is the moisture which evaporates during the process of manufacture. This moisture may be excessive in cotton picked early in the season and ginned without drying. There may, on the other hand, be a lack of moisture. The cotton may be overdry and appear harsh and brittle. Such cotton gives trouble in spinning, because of the electric current it develops.

The question of moisture is one of the most important connected with the handling of cotton. Either an excess of moisture or a lack of it reduces the grade. The farmer, however, must never add water to the cotton, but he should seek to retain the optimum amount of natural moisture. This means that to drive off excessive moisture freshly picked cotton should be sunned until the seeds will crack in the teeth. The staple will then be slightly overdry and unfit to gin or offer to the buyer. To restore its grade it should be "bulked." Bulking, as practiced on the Sea Islands, is placing the seed cotton, after sunning, in a large, deep, square pile in a cool room. It should be packed down solidly and, if the air is dry, covered with blankets or boards and left from three to six weeks before ginning. When it comes out of bulk the staple has lost its harsh feeling and is soft, oily, and glossy.

Care must be taken never to bulk cotton that has not previously been well dried, or the pile will heat. On the other hand, a loose, conical pile, formed by throwing seed cotton into a storeroom, is not a bulk, for it does not prevent the cotton from drying out still more. As a rule, cotton brought to the gins early in the season is too green and damp and needs sunning to put it into good condition, while that coming in late or taken from the storehouses during the winter is overdry and consequently harsh and brittle. Both the lint cotton and the thread spun from it lack their full strength if too dry. Everyone knows how a dry twig will snap in the fingers, while a

green one only bends. The same to a less degree is true of the cotton fiber. The quality is best maintained, however, by avoiding over-drying rather than by the addition of moisture.

(11) **Injury in ginning.**—The grade of cotton is often reduced during the process of ginning. This may be the fault of the farmer, as when he brings his cotton to the gin damp or full of hard or yellow locks or broken leaf and insists on close ginning; or the fault may lie with the ginner, who has failed to adjust his machines so that no seed can be broken. Briefly stated, seed cotton must be dry; if green or wet, “crimping” invariably results, to the serious injury of the fiber. The seed cotton should be free from hard locks or else the stripper bar should be adjusted to let them fall through with the seed. Close ginning is a form of adulteration instantly detected by the buyer and very costly to the farmer. The modern fruit grower has learned that he can not profitably mix his culls with his first-grade fruit, and the cotton grower must come to a similar conclusion.

The most frequent defects due to ginning are the presence of portions of broken seed and the cutting or crimping of the fiber. Since poor ginning costs the farmer, at a conservative estimate, 1 cent a pound, the ginner should be required to maintain his gin in perfect adjustment and to gin the cotton free from cracked, clipped, mashed, or whole seed and free from crimp.

The ginned cotton should come from the roller steadily and in an unbroken flake. Whenever it does not do this, an examination will show that the adjustment is not perfect, and the cotton is liable to sustain injury unless the trouble is corrected.

SUMMARY.

The best practice in handling the crop may be briefly stated by describing the method followed on the Sea Islands, which should be adopted in the interior in so far as the labor conditions will permit.

Picking is done whenever enough cotton is open, about every ten days. The cotton is gathered as free from trash as possible and carried to the storehouse, where the next morning each picker sorts his own picking. The cotton is then spread on arbors to dry in the sun. It is watched and turned frequently, and usually dries in one day. After sunning, the seed cotton is assorted by women, who remove any yellow locks, bits of leaf, etc. If very dirty it is whipped over a coarse wire screen stretched across a small box to take out the sand. Very fine cotton is again sorted or overhauled by another set of laborers. The cotton is then bulked and allowed to remain from four to six weeks before ginning. During the ginning, one or two hands inspect the cotton as it passes to the gins, to remove impurities, and one or two others “mote” the lint as it passes from the gin to the

press, by picking out yellow tufts, etc. By all these means a high grade is maintained for Sea Island cotton, which is reflected in a price per pound several cents higher than that paid for interior cotton.

DISEASES OF SEA ISLAND COTTON.

SORE-SHIN AND DAMPING-OFF.

Cotton seedlings sometimes become diseased shortly after coming up, particularly when soil or weather conditions are unfavorable. The term "sore-shin" is applicable to diseased spots or cankers formed on the stem or root of the seedling. These spots result in a cessation of growth, in yellow leaves, and, if they encircle the stem, in death.

A fungus (*Rhizoctonia*) is usually held responsible for the trouble, but it is only after cold and wet weather has checked growth and weakened the plants that serious loss results. If warm and favorable weather prevails the cotton soon outgrows the disease. No direct remedial measures are practicable. Danger of loss can be minimized by thorough preparation of the land before planting, by draining lower lying fields, and by thick seeding. Broken stands must be filled by replanting.

Damping-off, or the collapse of the stem at the surface of the ground, may be due to the sore-shin fungus or to other parasites. It is often caused by anthracnose, in which case the seed was probably infected before planting. The recommendations for the treatment of anthracnose on page 47 apply also to this form of it.

BACTERIAL BLIGHT.

There is a bacterial disease of cotton (*Bacterium malvacearum* Erw. Sm.) which is found to occur on different parts of the plant, producing various symptoms and receiving various names, such as angular leaf-spot, black-arm, boll-spot, etc., according to the point of attack. We describe all these together.

The earliest appearance of the disease is perhaps on the leaves, where it produces what is commonly known as the angular leaf-spot. These spots are at first a water-soaked green, becoming black when older. They are angular in outline, one-eighth to one-fourth inch in diameter. They are scattered over the leaf, but are often more numerous near the large veins. When one of these veins is attacked the disease rapidly extends its whole length.

Infection of the petiole is less common, but sometimes occurs, causing the leaf to turn yellow and fall off.

Infection of the pedicel of the bolls is a common cause of shedding and of failure to open. The bolls themselves are also attacked, the points of infection being water soaked at first and then growing darker. This organism does not appear to be as active a cause of

boll-rot as the anthracnose fungus and several bacteria which appear to follow it and which very likely gain entrance through the bacterial spot.

Young plants in June are sometimes attacked on the main stem, near the ground or higher up, where a canker is formed which so weakens the stem that it is broken off later by winds or during cultivation. It is later in the summer that most damage occurs, when the

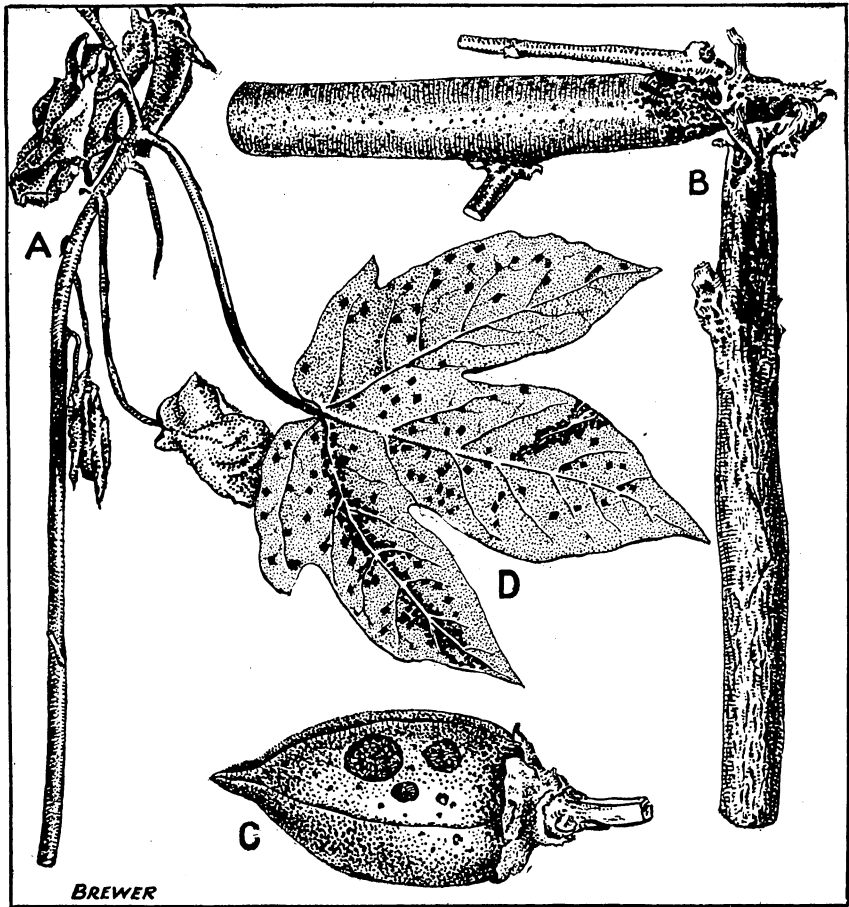


FIG. 10.—Diseased leaves, boll, and stems of cotton plant showing several forms of bacterial blight.

disease attacks the fruit-bearing limbs. The spots on the limbs are dark—nearly black—and, though not deep, so sap the vitality as to cause the shedding of all the smaller bolls. In many cases, when the season is wet, infection by anthracnose follows and adds to the injury. Several forms of the disease are illustrated in figure 10.

Egyptian cotton is peculiarly subject to this trouble—so much so that its cultivation in the Southeastern States appears to be impracticable. There is considerable variation in the resistance of different

rices of Sea Island cotton, Rivers, for instance, being rather susceptible, while Centerville is nearly immune.

Remedial measures must be indirect. Resistant varieties can be developed by selection. Diversification and rotation of crops will tend to reduce the amount of infectious material remaining on the land and will lessen the disease. Black-arm is probably carried through seed to some extent, and the selection of seed from healthy bolls only will greatly aid in its control. It may be expected that a reduction of the nitrogen and an increase in the amount of potash in the fertilizer, by inducing development of less succulent branches, will reduce the danger of infection



FIG. 11.—A plant recently affected with cotton wilt (on the right), with a healthy resistant plant growing beside it.

WILT.

Cotton wilt, often called black-root, is one of the most serious diseases of the crop wherever it occurs. It is characterized by the death of the plants in gradually enlarging spots in the field, where the disease reappears year after year. The plants are attacked at any time after they are a month old, but die fastest in June and July. The affected plants wilt, or a few leaves at a time turn yellow between the veins and fall off. (Fig. 11.) When the stem or root is cut the woody portion is found to be brown or black. The discoloration is one of the most characteristic symptoms of the disease and has given it the name black-root.

Wilt is most prevalent on the sandy or sandy loam soils best suited for Sea Island cotton. Low spots and rich bottom lands often escape the disease long after the cotton on the higher portions of the field is killed. Clay soils are, as a rule, free from it, though some cases are

reported. Geographically wilt occurs more or less in all the Sea Island cotton-growing districts, both in South Carolina and in the interior. It is also serious in Upland cotton fields from North Carolina to Louisiana.

Cause.

Wilt is due to a fungus (*Neocosmospora vasinfecta* [Atk.] Erw. Sm.) which enters the small roots from the soil, grows into the water-carrying vessels of the root and stem, and fills them, thus shutting off the water supply of the plant.

This fungus spreads by direct growth through the soil and also forms four kinds of spores, viz, one in the interior of the stem, another in cushions on the outside of dead plants, a third in the soil or on the surface of the plant, while the fourth or perfect spore stage is produced in minute bright-red sacs (perithecia) borne underground on the bark of the dead roots. This fungus is without doubt spread to some extent by the feet of stock passing through the fields, carried in drainage water from high to low land, and distributed by plows and cultivators. When it appears in a field, attempts to restrict its spread are useless, so far as the writer's knowledge goes. As wilt attacks only cotton and okra, good yields of corn and other crops can be obtained on infected land. A long period of rotation tends to diminish the amount of disease, but the fungus can live in the soil for several years, cases being on record where seven years' rest failed to free the land from wilt.

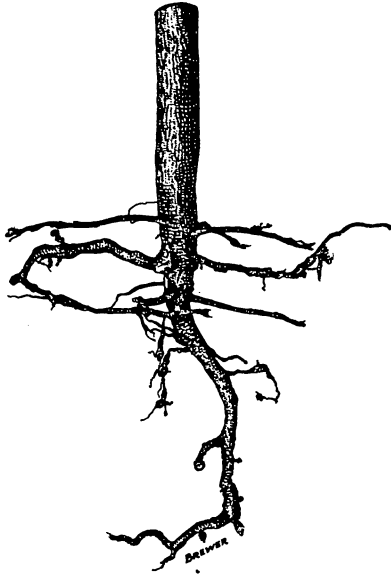


FIG. 12.—Roots of a cotton plant affected with root-knot.

An important point in connection with the question of rotation is the danger from root-knot, another disease, described on page 46, which often occurs along with the wilt.

Enlargements of the roots of cotton (fig. 12) indicate that root-knot is present and that a rotation of crops must be practiced to control it. The combined treatment of wilt and root-knot is based on the following principles:

(1) Cotton wilt attacks only cotton and okra. It does not disappear after rest or rotation. Resistant varieties can be secured.

(2) Root-knot attacks cotton, cowpeas, sweet potatoes, vetch, mel-

ons, and many other crops, but does not attack corn, oats, velvet beans, or the common grasses. It diminishes and finally disappears when all susceptible plants are kept off the field, and in ordinary farm practice can be held in check by a suitable rotation of crops. No variety of cotton is wholly resistant to root-knot.

A rotation similar to the following should therefore be adopted: First year, corn with Iron cowpeas or peanuts; second year, winter oats, or, if preferred, rye or wheat cut early for hay and followed at once with velvet beans; third year, cotton of a wilt-resistant variety.

Soil Treatment not a Successful Remedy.

It has been found impossible to kill out the fungus in the soil by any treatment with fungicides. Experiments have been made with lime, sulphur, copper sulphate, formalin, carbolic acid, and numerous other substances, none of which had any effect in reducing the amount of wilt.

The fungus is so spread through the soil that it is unlikely that it can ever be killed by any treatment that would be cheap enough to be practicable.

The Relation of Soil Conditions to Wilt.

It should be emphasized that wilt is due to the presence of a parasitic fungus, not to any unfavorable soil conditions. The fungus is, therefore, to be looked on as a weed and the disease may be expected to appear wherever its spores are carried. There are no chemical or physical differences between wilt-infected and healthy soils of the same type. Wilt is not due to the continual use of commercial fertilizers nor to the exhaustion of any element of plant food. Its preference for light and sandy soils has already been noted. Our experiments indicate that the free use of stable manure will assist in the control of wilt by increasing the vigor of resistant varieties, but the ordinary nonresistant kinds are not sufficiently protected by stable manure. In the same way other organic fertilizers, like compost and leguminous crops plowed under, will effect an improvement of the crop.

Control through the Use of Resistant Varieties.

It has been found possible to secure by seed selection varieties of Sea Island cotton resistant to wilt which will yield full crops of good quality on badly infected land, provided there is not too much root-knot present also. They were developed on the Sea Islands by selecting seed from exceptional plants that withstood the disease and remained healthy in the most infected spots. The first and best of these varieties is the Rivers, bred by Mr. E. L. Rivers, of James Island, S. C., in connection with the experiments of this Department. The Rivers cotton is productive, vigorous, compact, branching low, and with small, close-jointed limbs, often double

bearing; bolls medium size, 3 to 4 locks; seed small, black, with a small green tuft; average per cent of lint to seed 28, giving a ginning rate of 3.57; staple fully to extra fine, and when grown on the Sea Islands 2 inches long. The Rivers cotton is an excellent variety for the Sea Islands and for the best localities in the interior, but has too low a ginning rate to be popular there, although its total yield per acre compares favorably with any other. It has also shown some susceptibility to black-arm when cultivated in Georgia.

A second variety, the Centerville, was selected with special reference to interior conditions. It differs from the Rivers in having smaller and more numerous bolls and a shorter staple—1½ inches—with a ginning rate of 3.30. The Centerville variety is noteworthy in being almost immune to black-arm. It is not fine enough, however, for the Sea Islands, and has defects when grown in the interior, especially in that its bolls are small and are often set in greater numbers than the plant can mature, resulting in a tendency to dry up toward the end of the season.

Other resistant strains have been developed, but as they are not at present obtainable for cultivation in the interior they are not described here.

Farmers who have wilt-infected land should secure seed of a resistant variety or, failing in this, should plant some other crop than cotton on the disease-infected field.

Once a wilt-resistant variety is obtained its quality should be maintained by the method of selection already described. Dependence can no longer be placed on the hope of obtaining seed from outside growers.

Control through Originating New Varieties.

Anyone who will give the necessary time and care can develop new resistant strains from the resistant plants that occasionally appear in fields of ordinary cotton. He must be prepared, however, to continue the breeding for several years before the desired results are attained.

No one should gather seed promiscuously from an infected field with the idea of gradually developing a resistant variety, for such methods are costly and usually fail. Breed from individual plants instead.

ROOT-KNOT.

Root-knot is a common and widely distributed disease in sandy soils throughout the southern tier of States. The effect on the plant is to lessen its vigor and dwarf its size. The seat of the trouble is at the root, which becomes distorted and covered with small swellings or knots. (See fig. 12.) These are produced by a minute nematode worm (*Heterodera radicicola* [Greef.] Mül.) which penetrates the roots and lives within them. On breaking open a large knot one can

often detect minute pearl-like bodies, which are the female worms distended by masses of eggs.

Root-knot is a more serious enemy of peaches, vegetables, tobacco, and cowpeas than of cotton. It becomes of great importance to the cotton planter when it occurs in connection with wilt, which it very often does. The treatment required is the rotation of crops that has already been discussed under wilt.

ANTHRACNOSE.

The greater part of the loss from rotting of bolls is due to the disease known as anthracnose. This occurs as dark-colored spots on the bolls, which as they enlarge become depressed and gray or pink in the center. (See fig. 13.) The seed cotton in the bolls is discolored and spoiled. The cause is a parasitic fungus (*Colletotrichum gossypii* Swth.) which is very common throughout the cotton belt. While most of the injury is done to the bolls, the fungus can attack any other part of the plant. The disease is worse in wet seasons than in dry ones.

Remedies.

No direct remedy is practicable on account of the expense involved, but there are important preventive measures based on the fact that the disease is spread in part by seed from diseased plants. Where trouble from this disease is experienced, the seed for the next crop must be selected with care from perfectly healthy bolls. If a boll has one lock affected, there is danger that the fungus has penetrated all the seed. Avoid, if possible, running the selected seed cotton through a gin that has just been handling diseased cotton. All accessible parts of the machine should be wiped clean to prevent the fungus spores from remaining to infect the selected seeds.

Finally, when the crop is all picked, the old cotton stalks should be burned. Of these precautions the seed selection is the most important. It will not do as well to send away for seed from a healthy field, for the disease occurs everywhere.

RUST.

The disease commonly known as cotton rust is not primarily a fungous disease, but is caused by unfavorable soil conditions. Sea Island cotton fields affected by rust take on a reddish color, the leaves drop off, sometimes leaving the stalk bare, and the upper



FIG. 13.—Cotton boll affected with anthracnose.

bolls fail to open. The cotton from such rusted plants is very weak and inferior. Rust is likely to develop in definite spots in a field, and unless a remedy is applied will appear year after year. Though other factors sometimes influence particular cases, there are three principal causes of rust in cotton, as follows:

(1) Exhaustion of the humus. Continued cultivation in cotton, by destroying the vegetable matter of the soil, is the most frequent cause of rust. The color of these old fields in midsummer is a lighter green, with a tinge of yellow, followed, when the bolls begin to mature, by the appearance of rust. A newly cleared field or an old fence row is, on the other hand, always green and free from rust. Stable manure is the most effective remedy in such cases, but a crop of velvet beans or cowpeas plowed under will effect a great improvement.

(2) Deficiency of potash. Most soils where cotton shows a tendency to rust lack potash, and an application of 200 pounds of kainit or 50 pounds of muriate of potash per acre will prove an effective remedy. Such soils are, as a rule, also deficient in humus, and a rotation of crops is usually advisable also.

(3) Lack of drainage. Rust often develops in low, wet places in a field where the higher portions are free from it, and for the same reason heavy and continued rains in August and September may lead to the development of rust in certain fields. Drainage by ditching or by tiles will be required in extreme cases. Most of these fields, however, become stagnant because the soil has no water-absorbing capacity on account of its lack of humus. If a leguminous crop were turned under every other year or stable manure applied liberally and the land plowed deep, the soil would soon be so changed in condition that heavy rains would not injure it and rust would disappear.

BLUE COTTON.

Blue cotton is a peculiar disease which occurs to a limited extent on the Sea Islands and in Florida. It is characterized by the deep green or bluish color of the leaves, the prostrate habit of the plant, which develops numerous lateral sprouts, and the shedding of the fruit. It is caused by some physiological or nutritional disturbance of the plant due to soil conditions not fully understood. The use of cotton seed and other organic manures aggravates the trouble. It has been successfully remedied on the Sea Islands by the use of salt mud, by liming, and by drainage.

INSECT ENEMIES OF SEA ISLAND COTTON.

The cotton caterpillar or leaf worm is the principal insect pest the Sea Island planter has to deal with, though slight injuries are sometimes inflicted by other insects. Readers are referred to Farmers' Bulletins Nos. 47 and 223 for full information relative to their control.